

## **Do partnered women discriminate men's faces less along the attractiveness dimension?**

Hongyi Wang<sup>1</sup>, Amanda C. Hahn<sup>1</sup>, Lisa M. DeBruine<sup>1</sup> & Benedict C. Jones<sup>1</sup>

1. Institute of Neuroscience & Psychology, University of Glasgow, Glasgow, G12 8QB, UK.

### **Corresponding author address**

Hongyi Wang, Institute of Neuroscience & Psychology,  
University of Glasgow, Glasgow, G12 8QB, UK.

Tel: +44 141 330 5089

### **Corresponding author email**

[h.wang.4@research.gla.ac.uk](mailto:h.wang.4@research.gla.ac.uk)

### **Acknowledgement**

This research was funded by European Research Council Grant OCMATE 282655.

## **Abstract**

Romantic relationships can have positive effects on health and reproductive fitness. Given that attractive potential alternative mates can pose a threat to romantic relationships, some researchers have proposed that partnered individuals discriminate opposite-sex individuals less along the physical attractiveness dimension than do unpartnered individuals. This effect is proposed to devalue attractive (i.e., high quality) alternative mates and help maintain romantic relationships. Here we investigated this issue by comparing the effects of men's attractiveness on partnered and unpartnered women's performance on two response measures for which attractiveness is known to be important: memory for face photographs (Study 1) and the reward value of faces (Study 2). Consistent with previous research, women's memory was poorer for face photographs of more attractive men (Study 1) and more attractive men's faces were more rewarding (Study 2). However, in neither study were these effects of attractiveness modulated by women's partnership status or partnered women's reported commitment to or happiness with their romantic relationship. These results do not support the proposal that partnered women discriminate potential alternative mates along the physical attractiveness dimension less than do unpartnered women.

**Key words:** facial attractiveness; reward; memory; partnership; mating

## 1. Introduction

Romantic relationships have positive effects on reproductive fitness by increasing resources available for investment in offspring (Buss & Schmitt, 1993). Romantic relationships also have positive effects on both physical and psychological health (House et al., 1988). Given the importance of physical attractiveness for human mate choice (e.g., Thornhill & Gangestad, 1999), several researchers have proposed that partnered individuals might discriminate opposite-sex individuals along the physical attractiveness dimension less than do unpartnered individuals (Karremans et al., 2011; Ritter et al., 2010). These differences are thought to function to devalue attractive (i.e., high quality, Thornhill & Gangestad, 1999) alternative mates (Karremans et al., 2011; Ritter et al., 2010). Devaluing attractive alternative mates may help to maintain romantic relationships by reducing the likelihood of the pursuit of alternative mates.

Recent evidence for the proposal described above has come from research that used a reverse-correlation technique (Mangini & Biederman, 2004) to visualize heterosexual women's internal representations of previously seen attractive and unattractive men's faces (Karremans et al., 2011). Karremans et al. (2011) found that partnered women's internal representations of *attractive* men's faces were *less* attractive than those of unpartnered women, By contrast, partnered women's representations of *unattractive* men's faces were *more* attractive than those of unpartnered women. These results were interpreted as evidence that partnered women discriminate men's faces along the physical attractiveness dimension less. This interpretation is consistent

with findings from other studies where, when instructed to disregard their own current partnership status, partnered participants are less likely to identify physically attractive individuals as potential romantic partners than are unpartnered participants (Ritter et al., 2010). They are also consistent with research where partnered individuals rated photographs of highly attractive people to be less attractive than did unpartnered individuals (Simpson et al., 1990).

The aim of the current study was to test for further evidence that partnered women discriminate men's faces along the physical attractiveness dimension less than do unpartnered women. We did this by comparing the effects of men's facial attractiveness on partnered and unpartnered women's performance on two measures for which attractiveness is known to be important. In Study 1, we assessed partnered and unpartnered women's memory for photographs of men's faces using an "old-new" memory task (Macmillan & Creelman, 2005), in which women watched a slideshow of images of men's faces that had previously been rated for attractiveness by a different group of participants. The women were then shown both these face images and foil images (i.e., were shown these "old" face images interspersed among previously unseen "new" male face images), and were asked to indicate whether or not they had seen each face photograph before. Previous research suggests that more attractive faces are less memorable (e.g., Wiese et al., 2014), but has not investigated the possible effects of women's partnership status. If partnered women discriminate men's faces along the physical attractiveness dimension less than do unpartnered women

(Karremans et al., 2011), the predicted negative effect of attractiveness on the memorability of photographs of men's faces should be weaker in partnered than unpartnered women.

In Study 2, we used a standard key-press task (Aharon et al., 2001; Levy et al., 2008; Hahn et al., 2014, 2015; Wang et al., 2014) to assess the reward value of images of men's faces in partnered and unpartnered women. In this task, participants can control the length of time for which they view faces by repeatedly pressing keys to either increase or decrease the viewing time (Aharon et al., 2001; Levy et al., 2008; Hahn et al., 2014, 2015; Wang et al., 2014). Responses on this type of key-press task are a better predictor of neural measures of the reward value and motivational salience of face images than attractiveness ratings (Aharon et al., 2001). As in Study 1, our male face stimuli had previously been rated for attractiveness by a different group of participants. The same face stimuli were used in both studies. Previous research has found that more attractive male faces have greater reward value to women (Levy et al., 2008; Hahn et al., 2014, 2015; Wang et al., 2014). However, this work has not considered the possible effects of women's partnership status. If partnered women discriminate men's faces along the physical attractiveness dimension less than do unpartnered women, the predicted positive effect of attractiveness on the reward value of men's faces should be weaker in partnered than unpartnered women.

## **2. Study 1**

The aim of Study 1 was to test whether the effect of facial attractiveness on women's memory for photographs of men's faces was different for partnered and unpartnered women. Weaker effects of facial attractiveness on partnered women's memory for photographs of men's faces would support the proposal that partnered women differentiate men's faces along the attractiveness dimension less.

## **2.1. Method**

### **2.1.1. Face stimuli and attractiveness ratings**

Face stimuli were images of 50 young adult white men (mean age=24.24 years,  $SD=3.99$  years; range: 18 to 33 years), photographed under standardized lighting conditions and posed front-on to the camera with direct gaze and neutral expressions. Images were aligned on pupil position and cropped so that clothing was not visible. Images were obtained from a commercially available database ([www.3D.sk](http://www.3D.sk)).

The 50 male face images were rated for attractiveness by 100 heterosexual women and 100 heterosexual men (mean age=24.67 years,  $SD=5.87$  years; range: 18 to 40.7 years) using a 1 (much less attractive than average) to 7 (much more attractive than average) scale. Trial order was fully randomized. This part of the study was run online, with participants recruited from links on social bookmarking websites (e.g., [stumbleupon.com](http://stumbleupon.com)). Participants did not receive any payment. Inter-rater agreement was high for these ratings (Cronbach's  $\alpha=.99$ ) and mean ratings derived from female and male raters• scores were highly correlated ( $r=.97$ ,  $N=50$ ,  $p<.001$ ). Thus, we combined

ratings from female and male raters to produce a single attractiveness score for each face. These average scores were used in our main analyses.

### **2.1.2. Face memory task**

The same face images presented in the face rating part of the study were also used in the memory task, which was completed by 350 heterosexual women (mean age=22.65 years,  $SD=5.43$  years; range: 16 to 39.7 years) who had not taken part in the rating part of the study. These participants reported whether they were currently in a romantic relationship ( $N=165$ ) or currently not in a romantic relationship ( $N=185$ ) by answering yes or no to the question “Do you have a partner? (e.g. a boyfriend, husband, etc.)”. Participants who reported being in a romantic relationship also reported how happy they were in their relationship with their partner ( $M=5.72$ ,  $SD=1.37$ ) and how committed they were to their relationship with their partner ( $M=5.87$ ,  $SD=1.34$ ) using 1 (much less happy/committed than average) to 7 (much more happy/committed than average) rating scales.

In an initial exposure phase, participants were shown half of the male faces. In this exposure phase, images were presented in a fully randomized order and each image shown once for 2000ms (i.e., the exposure phase lasted 50 seconds in total). In a test phase immediately after the exposure phase, participants were shown all of the male faces, again in a fully randomized order, and were asked to indicate whether or not they had seen each face during the exposure phase. Which individual faces were shown during the exposure phase was counterbalanced across participants. Participants were

told prior to the exposure phase that it would be followed by a memory test. This part of the study was also run online. Participants were again recruited from links on social bookmarking websites and did not receive any payment.

For each face, we used the proportion of women who correctly identified it as having been seen previously to calculate the hit rate for performance on the memory task. This was calculated separately for partnered women ( $M=.78$ ,  $SD=.09$ ) and unpartnered women ( $M=.78$ ,  $SD=.09$ ). The proportion of women who incorrectly identified a face as having been seen previously was used to calculate the corresponding false alarm rate for each face. Again, this was calculated separately for partnered women ( $M=.21$ ,  $SD=.12$ ) and unpartnered women ( $M=.20$ ,  $SD=.12$ ). Hit rates and false alarm rates were used to calculate d-prime for each face separately for partnered women ( $M=1.73$ ,  $SD=0.69$ ) and unpartnered women ( $M=1.74$ ,  $SD=0.64$ ). We used d-prime in our analyses because it is an unbiased measure of memory performance that considers both the hit and false-alarm rates (i.e., it takes into account response bias, Macmillan & Creelman, 2005).

## **2.2. Results**

First, d-prime was analyzed using ANCOVA, with *men's facial attractiveness* as the covariate and *women's partnership status* (partnered, unpartnered) as a within-items factor. There was a significant main effect of *men's facial attractiveness* ( $F(1,48)=12.66$ ,  $p=.001$ , partial  $\eta^2=.21$ ). Neither the main effect of *women's partnership status* nor the interaction between *women's partnership status* and *men's facial attractiveness* were significant (both



$F(1,48) < 0.52$ , both  $p > .47$ , both partial  $\eta^2 < .01$ ). The main effect of *men's facial attractiveness* indicated that memory was poorer for more attractive male faces (overall:  $r = -.47$ ,  $N = 50$ ,  $p = .001$ ; partnered women:  $r = -.45$ ,  $N = 50$ ,  $p = .001$ ; unpartnered women:  $r = -.43$ ,  $N = 50$ ,  $p = .002$ ).

Next, we tested whether the effect of attractiveness on memory for faces differed between partnered women who reported being committed to and happy in their relationship and those who reported being less committed to and less happy in their relationship. Because partnered women's relationship happiness and commitment ratings were highly and positively correlated ( $r = .55$ ,  $N = 165$ ,  $p < .001$ ), we converted the relationship happiness and commitment ratings to z-scores and averaged them. We then separately calculated d-prime for those partnered women who scored above the median on the combined relationship commitment/happiness score and those partnered women who scored below the median on the combined relationship commitment/happiness score. Analyzing these scores using ANCOVA, with *men's facial attractiveness* as the covariate and *women's relationship type* (high commitment and happiness, low commitment and happiness) as a within-items factor showed a significant main effect of *men's facial attractiveness* ( $F(1,48) = 14.61$ ,  $p < .001$ , partial  $\eta^2 = .23$ ) and *women's relationship type* ( $F(1,48) = 5.13$ ,  $p = .03$ , partial  $\eta^2 = .10$ ). The interaction between *women's relationship type* and *men's facial attractiveness* was not significant ( $F(1,48) = 2.24$ ,  $p = .14$ , partial  $\eta^2 = .04$ ). The main effect of *men's facial attractiveness* indicated that memory was poorer for more attractive male faces (overall:  $r = -.45$ ,  $N = 50$ ,  $p = .001$ ; high commitment and happiness

group:  $r=-.43$ ,  $N=50$ ,  $p=.002$ ; low commitment and happiness group:  $r=-.49$ ,  $N=50$ ,  $p<.001$ ). And the main effect of *women's relationship type* indicated that memory for male faces were poorer among women who scored high in commitment and happiness than those scored low in commitment and happiness. That the interaction between *men's facial attractiveness* and *women's relationship type* was not significant suggests that the effect of men's attractiveness on partnered women's memory for men's faces is not affected by the women's reported commitment to and happiness with their current romantic relationship.

### **3. Study 2**

The aim of Study 2 was to test whether the effect of facial attractiveness on the reward value of men's faces to women was different for partnered and unpartnered women. Weaker effects of facial attractiveness on the reward value of men's faces in partnered women would support the proposal that partnered women differentiate men's faces along the attractiveness dimension less.

#### **3.1. Methods**

One thousand heterosexual women (mean age=21.97 years,  $SD=4.55$  years; range: 16 to 40 years) took part in the study. These participants reported whether they were currently in a romantic relationship ( $N=500$ ) or currently not in a romantic relationship ( $N=500$ ) by answering yes or no to the question "Do you have a partner? (e.g. a boyfriend, husband, etc.)". Using the same 7-point scales we used in Study 1, participants who reported being in a romantic

relationship also reported how happy they were in their relationship with their partner ( $M=5.59$ ,  $SD=1.44$ ) and how committed they were to their relationship with their partner ( $M=5.84$ ,  $SD=1.40$ ). Three partnered participants opted not to report this information. All participants completed a standard key-press task, similar to those used to assess the reward value of faces in previous studies (Aharon et al., 2001; Levy et al., 2008; Hahn et al., 2014, 2015; Wang et al., 2014). The study was run online. Participants were recruited from links on social bookmarking websites and did not receive any payment. Previous research has reported similar effects of attractiveness on the reward value of men's faces in studies conducted in the laboratory (Levy et al., 2008; Wang et al., 2014) and those conducted online (Hahn et al., 2014, 2015).

In the key-press task, the 50 male faces used in Study 1 were presented in a fully randomized order. Participants controlled the viewing duration of each face image by repeatedly pressing designated keys on their keyboard after initiating each trial by pressing the space bar. Participants could increase the length of time a given face was displayed by alternately pressing the 7 and 8 keys and/or decrease the length of time a given face was displayed by alternately pressing the 1 and 2 keys. Each key press increased or decreased the viewing duration by 100ms. The default viewing duration for each image (i.e., the length of time a face remained onscreen if no keys were pressed) was 4 seconds. Participants were told that the key-press task would last for a total of 3.5 minutes in order to discourage responses aimed at changing the length of engagement with the task. However, in reality, the total length of the key-press task was dependent on participants' responses. Participants

completed a block of practice trials at the start of the test to ensure they understood the task (face images were not shown in this block of practice trials). All participants key-pressed at least once during the task.

Following previous studies of the reward value of faces (Aharon et al., 2001; Levy et al., 2008; Hahn et al., 2014, 2015; Wang et al., 2014), key-press scores for each face were calculated by subtracting the number of key presses made to decrease viewing time from those made to increase viewing time. Inter-rater agreement was high for the key-press scores for both partnered (Cronbach's  $\alpha=.89$ ) and unpartnered women (Cronbach's  $\alpha=.87$ ). These scores were averaged for each face separately for partnered women ( $M=-3.87$ ,  $SD=4.84$ ) and unpartnered women ( $M=-3.18$ ,  $SD=5.57$ ) and served as the dependent variable in our analysis. Faces with greater key press scores are those with greater reward value (Aharon et al., 2001). The mean attractiveness ratings of men's faces from Study 1 were also used in our analysis of key-press scores in Study 2.

### **3.2. Results**

Similar to the analysis used in Study 1, key-press scores were analyzed using ANCOVA, with *men's facial attractiveness* as the covariate and *women's partnership status* (partnered, unpartnered) as a within-items factor. There was a significant main effect of *men's facial attractiveness* ( $F(1,48)=78.46$ ,  $p<.001$ , partial  $\eta^2=.62$ ). Neither the main effect of *women's partnership status* nor the interaction between *women's partnership status* and *men's facial attractiveness* were significant (both  $F(1,48)<1.31$ , both  $p>.25$ , both

partial  $\eta^2 < .03$ ). The main effect of *men's facial attractiveness* indicated that the reward value of men's faces was more pronounced for more attractive male faces (overall:  $r = .79$ ,  $N = 50$ ,  $p < .001$ ; partnered women:  $r = .82$ ,  $N = 50$ ,  $p < .001$ ; unpartnered women:  $r = .75$ ,  $N = 50$ ,  $p < .001$ ).

Next, we tested whether the effect of attractiveness on key-press scores differed between partnered women who reported being committed to and happy in their relationship and those who reported being less committed to and less happy in their relationship. As in Study 1, women's relationship happiness and commitment ratings were highly and positively correlated ( $r = .63$ ,  $N = 497$ ,  $p < .001$ ), so we converted these ratings to z-scores and averaged them. We then separately calculated mean key-press scores for those partnered women who scored above the median on the combined relationship commitment/happiness score and those partnered women who scored below the median on the combined relationship commitment/happiness score. Analyzing these scores using ANCOVA, with *men's facial attractiveness* as the covariate and *women's relationship type* (high commitment and happiness, low commitment and happiness) as a within-items factor showed a significant main effect of *men's facial attractiveness* ( $F(1,48) = 101.66$ ,  $p < .001$ , partial  $\eta^2 = .68$ ), but not a main effect of *women's relationship type* ( $F(1,48) = 1.22$ ,  $p = .28$ , partial  $\eta^2 = .03$ ). The interaction between *women's relationship type* and *men's facial attractiveness* was also not significant ( $F(1,48) = 3.35$ ,  $p = .07$ , partial  $\eta^2 = .07$ ). The main effect of *men's facial attractiveness* indicated that the reward value of men's faces was more pronounced for more attractive male faces (overall:  $r = .82$ ,

N=50,  $p < .001$ ; high commitment and happiness group:  $r = .79$ , N=50,  $p < .001$ ; low commitment and happiness group:  $r = .84$ , N=50,  $p < .001$ ). These results suggest that the effect of men's attractiveness on the reward value of men's faces is not significantly affected by the women's reported commitment to and happiness with their current romantic relationship.

#### **4. Discussion**

In Study 1, there was a negative correlation between d-prime scores and facial attractiveness, indicating that women's memory was generally poorer for photographs of more attractive men's faces. This pattern of results is consistent with other recent work that reported poorer memory for more attractive faces (e.g., Wiese et al., 2014). Although distinctiveness ratings of faces are negatively correlated with attractiveness (Rhodes, 2006) and positively correlated with face memorability (e.g., Valentine, 1991), recent work has shown that the effects of distinctiveness alone do not explain poorer memory for more attractive faces (Wiese et al., 2014).

In Study 2, attractiveness had a positive effect on key-press scores for men's faces, indicating that more attractive men's faces were more rewarding to women. This pattern of results is consistent with previous research that also reported positive effects of attractiveness on this measure of the reward value of men's faces (Levy et al., 2008; Hahn et al., 2014, 2015; Wang et al., 2014).

While both studies show that women generally discriminate men's faces along the attractiveness dimension, we found no evidence that the relationships

between attractiveness and memory for men's faces or attractiveness and the reward value of men's faces were significantly different for partnered and unpartnered women or for partnered women who scored above or below the median on a combined relationship happiness and commitment score. Thus, our data do not support the proposal that partnered women discriminate men's faces along the attractiveness dimension less than do unpartnered women. Consequently, while previous research has shown that partnered and unpartnered women's internal representations of previously seen attractive and unattractive men's faces appear to differ (Karremans et al., 2011), these representational differences do not appear to be sufficient to cause comparable differences in the effects of attractiveness on face memory or the reward value of faces. Nonetheless, we note here that the interaction between partnered women's commitment to / happiness with their relationship and male attractiveness approached significance in Study 2 ( $p=.07$ ). This suggests that partnered women's commitment to / happiness with their relationship may have a weak effect on the extent to which they find attractive male faces rewarding. However, the attractiveness effect for partnered women in the high-happiness group ( $r = .79$ ), while lower than the effect for women in the low-happiness group ( $r = .84$ ), was still stronger than the effect for women in the unpartnered group ( $r = .75$ ).

Previous research has reported that participants in a committed relationship were less likely to attend to attractive opposite-sex faces than were participants who were not in a committed relationship, but only if their mating motivation had been primed (Maner, Gailliot, & Miller, 2009). Other work

reported that participants in a committed relationship rated the attractiveness of attractive opposite-sex individuals lower than participants who were not in a committed relationship did, but only when they were instructed that the target individual was romantically unattached (Lydon, Fitzsimons, & Naidoo, 2003). These findings suggest that effects of women's partnership status on their sensitivity to men's attractiveness could be contingent on factors such as the women's own mating motivation and/or beliefs about the target's availability. These results, together with our own null results for effects of women's partnership status and partnered women's relationship commitment and happiness, suggest that women's own relationship status contributes little to individual differences in the extent to which they discriminate among men based on their attractiveness. That effects of women's partnership status on their sensitivity to men's attractiveness can be contingent on factors such as the women's own mating motivation and/or beliefs about the target's availability may explain why some studies have observed clear differences between partnered and unpartnered women in the extent to which they discriminate men on the attractiveness dimension (Karremans et al., 2011) while others have not. Other factors that have been found to influence women's responses to attractive faces, such as changes in their hormone levels (Wang et al., 2014), could also have obscured between-group differences in sensitivity to facial attractiveness. Another potential reason for discrepancies in results is that, while some studies have included stimuli representing a diverse range of attractiveness (e.g., the current study), others have compared responses to stimuli of high and average attractiveness only (Maner et al., 2009).



Karremans et al. (2011) previously reported that partnered women's internal representations of *attractive* men's faces were *less* attractive than those of unpartnered women, but that their representations of *unattractive* men's faces were *more* attractive than those of unpartnered women. They suggested (1) that these results indicated that partnered women discriminated men's faces along the physical attractiveness dimension less than unpartnered women and (2) that this may help maintain partnered women's romantic relationships by devaluing attractive alternative mates. However, having more attractive representations of *unattractive* men's faces would potentially cause women to perceive unattractive (i.e., low quality, Thornhill & Gangestad, 1999) alternative mates to be more attractive than they actually are, which could have negative consequences for their reproductive fitness if this increases the chances of women choosing unattractive mates for extra-pair or replacement mates. This possibility raises questions about the extent to which the type of biased representations of male faces reported by Karremans et al. (2011) for partnered women would necessarily benefit their reproductive fitness. Indeed, other researchers have suggested that women's reproductive fitness may actually benefit from extra-pair mating with high quality mates (e.g., Gangestad & Simpson, 2000). Doing so would require that partnered women retain the ability to discriminate potential mates along the attractiveness dimension. Consistent with the possibility that discriminating among men on the attractiveness (i.e., quality) dimension may be beneficial to *both* partnered and unpartnered women, our studies showed no differences between partnered and unpartnered women's sensitivity to male facial attractiveness

on two measures for which attractiveness is known to be important (memory for faces and the reward value of faces).

## 5. References

- Aharon, I., Etcoff, N., Ariely, D., Chabris, C. F., O'Connor, E., & Breiter, H. C. (2001). Beautiful faces have variable reward value: fMRI and behavioral evidence. *Neuron*, 32(3), 537–551. doi:10.1016/S0896-6273(01)00491-3.
- Buss, D. M., & Schmitt, D. P. (1993). Sexual strategies theory: An evolutionary perspective on human mating. *Psychological Review*, 100(2), 204–232. doi:10.1037/0033-295X.100.2.204.
- Gangestad, S. W., & Simpson, J. A. (2000). The evolution of human mating: trade-offs and strategic pluralism. *Behavioral and Brain Sciences*, 23(4), 573–644. doi:10.1017/S0140525X0000337X.
- Hahn, A. C., Fisher, C. I., DeBruine, L. M., & Jones, B. C. (2014). Sex ratio influences the motivational salience of facial attractiveness. *Biology Letters*, 10(6), 20140148. doi: 10.1098/rsbl.2014.0148
- Hahn, A. C., Fisher, C. I., DeBruine, L. M., & Jones, B. C. (2015). Sex-specificity in the reward value of facial attractiveness. *Archives of Sexual Behavior*, in press. doi:10.1007/s10508-015-0509-1.
- House, J. S., Landis, K. R., & Umberson, D. (1988). Social relationships and health. *Science*, 241(4865), 540–545. doi:10.1126/science.3399889.
- Karremans, J. C., Dotsch, R., & Corneille, O. (2011). Romantic relationship status biases memory of faces of attractive opposite-sex others: Evidence from a reverse-correlation paradigm. *Cognition*, 121(3), 422–426. doi:10.1016/j.cognition.2011.07.008.

- Levy, B., Ariely, D., Mazar, N., Chi, W., Lukas, S., & Elman, I. (2008). Gender differences in the motivational processing of facial beauty. *Learning and Motivation*, 39(2), 136–145. doi:10.1016/j.lmot.2007.09.002.
- Lydon, J. E., Fitzsimons, G. M., & Naidoo, L. (2003). Devaluation versus enhancement of attractive alternatives: A critical test using the calibration paradigm. *Personality and Social Psychology Bulletin*, 29(3), 349-359. doi: 10.1177/0146167202250202.
- Macmillan, N. A., & Creelman, C. D. (2005). Detection theory: A user's guide (2nd ed.). Mahwah, NJ: Erlbaum.
- Maner, J. K., Gailliot, M. T., & Miller, S. L. (2009). The implicit cognition of relationship maintenance: Inattention to attractive alternatives. *Journal of Experimental Social Psychology*, 45(1), 174-179. doi: 10.1016/j.jesp.2008.08.002
- Mangini, M. C., & Biederman, I. (2004). Making the ineffable explicit: Estimating the information employed for face classifications. *Cognitive Science*, 28(2), 209–226. doi:10.1016/j.cogsci.2003.11.004.
- Rhodes, G. (2006). The evolutionary psychology of facial beauty. *Annual Review of Psychology*, 57, 199-226. doi: 10.1146/annurev.psych.57.102904.190208
- Ritter, S. M., Karremans, J. C., & van Schie, H. T. (2010). The role of self-regulation in derogating attractive alternatives. *Journal of Experimental Social Psychology*, 46(4), 631–637. doi:10.1016/j.jesp.2010.02.010.
- Simpson, J. A., Gangestad, S. W., & Lerma, M. (1990). Perception of physical attractiveness: Mechanisms involved in the maintenance of romantic relationships. *Journal of Personality and Social Psychology*, 59(6), 1192.

- Thornhill, R., & Gangestad, S. (1999). Facial attractiveness. *Trends in Cognitive Sciences*, 3(12), 452–460. doi:10.1016/S1364-6613(99)01403-5.
- Valentine, T. (1991). A unified account of the effects of distinctiveness, inversion, and race in face recognition. *The Quarterly Journal of Experimental Psychology*, 43(2), 161-204. doi: 10.1080/14640749108400966.
- Wang, H., Hahn, A. C., Fisher, C. I., DeBruine, L. M., & Jones, B. C. (2014). Women's hormone levels modulate the motivational salience of facial attractiveness and sexual dimorphism. *Psychoneuroendocrinology*, 50, 246-251. doi:10.1016/j.psyneuen.2014.08.022.
- Wiese, H., Altmann, C. S., & Schweinberger, S. R. (2014). Effects of attractiveness on face memory separated from distinctiveness: Evidence from event-related brain potentials. *Neuropsychologia*, 56, 26-36. doi:10.1016/j.neuropsychologia.2013.12.023